TAR AND NICOTINE RETRIEVAL FROM FIFTY-SIX BRANDS OF CIGARETTES

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Tar and nicotine yields of 56 brands of cigarettes are determined. Tar yields range from a low of about 8 mg per cigarette to a high of about 43 mg per cigarette. Nicotine yields, which closely correlate with tar yields in most cases, range from about 0.3 to 2.6 mg per cigarette. There are substantial differences among cigarettes of the same general type. Among cigarettes without filters tar yield depends chiefly on the length of the cigarette. Filter cigarettes show the greatest variability in tar yield, ranging from 8 to 42 mg per cigarette. Among cigarettes with filters tar yield depends on the length of the cigarette and the weight of the filter, longer cigarettes and light-weight filters being associated with higher tar yields. It seems clear that manufacturers are able to produce cigarettes with almost any yield of tar and nicotine from very low to very high. This potentiality is important in the control of diseases caused by cigarette smoking.

THE BIOLOGICAL ACTIVITY OF TOBACCO SMOKE has been demonstrated extensively in human beings and experimental animals.[18] The ability of tobacco smoke to induce cancer in human beings is paralleled by its ability to provoke various kinds of malignant lesions in several animal species.[19] In common with most carcinogens, tobacco smoke shows a dose-dependent relationship that can be plotted from both human and animal data.[1, 6, 7, 9, 21] The importance of keeping exposure of the bronchial system to tobacco smoke to a minimum until such a time that it is possible to remove the offending noxious materials is apparent to all sincere students of this major public health problem. Practical techniques include the following:

1. Cessation of deep inhalation, either by voluntary effort or by changing from cigarettes to pipes and cigars, which tend to discourage deep inhalation;
2. Alteration of the tobacco in cigarettes so that the resulting effects on the pH or other characteristics of the smoke similarly discourage deep inhalation;
3. Smoking fewer cigarettes;
4. Smoking less of each cigarette;
5. Using filters that appreciably reduce the quantity of smoke particulate that reaches the tissues.

This paper summarizes the relative amounts of total particulate matter (i.e., "tar") and total alkaloids (i.e., "nicotine") recovered from the mainstream smoke of commercial cigarettes of different lengths and compositions, with and without filters. We are well aware that modifications in the protocol can result in somewhat different yields of tar and nicotine. Despite such reservations, however, the data obtained are useful in comparing the potential biological effects of different kinds of cigarettes.

METHODS AND MATERIALS

Cigarettes of 56 brands were purchased, mostly from a single local retail outlet. The gross physical characteristics of the cigarettes are summarized in Table 1. Routinely, cigarettes were removed from packs and stored at room temperature and 60 ± 2% relative humidity for 48 hours. On the day that cigarettes were smoked, they were selected to fall within prescribed ranges for weight (±5 mg) and resistance to air flow (± 0.25 inches of water at a flow rate of 17.5 ml/sec). Immediately after selection, each cigarette was care-

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TABLE 1. Physical Characteristics of Cigarettes Smoked

Brand	Type*		Selected wt. (Gm) mid range	Selected resistance (inches of H_2O) mid range	Average puffs per cigarette	Average butt length (mm)
Marvels	F	85	1.081	4.8	9.0	29.3
			1.078	4.9		
Cascade	FM	85	1.066	4.5	9.2	27.3
			1.132	4.9		
Carlton	F	80	1.095	2.6	9.1	34.6
King Sano	FD	85	1.327	5.0	9.8	29.4
Duke	F	85	1.151	3.2	7.0	32.5
Life	F	85	0.993	3.9	8.3	31.9
True	F	85	1.090	3.6	8.3	33.4
			1.056	2.8		
Kent	F	85	1.019	3.6	10.2	26.2
			1.023	3.6		
Montclair	FM	80	1.103	2.6	10.0	28.6
Spring	FM	85	1.046	3.2	9.8	28.2
Galaxy	F	85	1.145	3.1	9.4	28.1
Marlboro	F	80	0.995	3.1	9.5	24.8
				3.3		
Winston	F	80	1.054	3.3	10.9	24.6
			1.051	3.0		
Old Gold	F	85	1.022	3.4	9.6	28.6
			0.987	3.1		
Waterford	F	80	1.131	3.1	8.6	30.5
Lark	F	85	1.247	3.8	10.8	27.6
Philip Morris	F	85	1.120	3.0	9.2	28.4
			1.174	2.2		
Newport	FM	80	0.965	2.8	8.9	24.8
Viceroy	F	85	1.085	3.1	10.8	27.5
Salem	FM	85	1.125	3.2	11.1	24.4
Paxton	FM	85	1.141	3.2	9.9	28.3
Parliament	F	85	1.169	3.8	9.5	27.5
L & M	F	70	0.945	3.2	9.0	22.9
Benson & Hedges	F	70	0.890	3.2	8.5	22.5
Tempo	F	85	1.333	3.2	10.1	28.1
			1.339			
Tareyton	F	85	1.137	3.3	10.9	23.1
			1.133	3.0		
Alpine	FM	85	1.120	3.7	9.3	28.2
			1.055	3.2		
Kool	FM	85	0.994	3.2	10.3	28.1

* F—filtered, M—menthol; number is length in mm to nearest 5 mm.

fully wrapped in aluminum foil to reduce exposure to the air while other cigarettes were being smoked.

The cigarette smoking machine was designed by Schur and Rickards.[16] With this machine, cigarettes were puffed individually for 2 sec of each minute. The smoke was passed through a standard plastic chamber* equipped with a Cambridge C-113 filter.† For the present study 8 of the potential smoking ports were used. At the beginning of each smoking day the volume of air drawn through individual cigarettes was checked to make sure that it was 35 ± 1 ml for each port.

Immediately before placement in the cigarette holder, each cigarette was marked lightly with a pencil to indicate the desired butt length. For cigarettes without filters, the standard 23-mm butt length recommend by Bradford et al.[4] was adopted. For cigaret with filters or paper overwraps longer th 20 mm a butt length 3 mm longer than filter or overwrap was taken as standard.

There were at least 3 filter pads for e brand and 4 cigarettes were smoked with e filter pad. A control brand (regular size Li Strike) was smoked on one port each smo day.

Tar and nicotine were analyzed accor to the methods described by Ogg.[18] The pl holder and filter were weighed before after 4 cigarettes were smoked and th crease in weight was defined as the tar. T alkaloids, determined with a Griffith still a Cary Model 11 spectrophotometer, reported as nicotine.

A survey of local retail markets showed one brand of cigarettes (Carlton) was on in packs of 3 distinctly different designs

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availability of "very ail market suggested oving brands might ngly, we "equilibra brand (Lucky Strik % and 100% relati sis.

another test of e tested some relat ving) brands after

* Phipps and Bird, Richmond, Va.
† Cambridge Filter Corp., Syracuse, N. Y.
‡ Consolidated Glass Works, Kingsport, Tenn.

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E 1. Physical Charac... Cigarettes Smoked

verage puffs er cigarette	Average ... length (...	Brand	Type*		Selected wt. (Gm) mid range	Selected resistance (inches of H_2O) mid range	Average puffs per cigarette	Average butt length (mm)
9.0	29	...sterfield		70	1.044	2.2	9.6	23.8
					1.035	2.4		
9.2	27	...ky Strike		70	1.022	2.6	8.5	23.1
					0.976	2.2		
9.1	34.0	...s	FM	85	1.066	3.6	9.5	24.9
9.8	29.7	...ky Strike	F	85	1.078	3.0	10.7	27.7
7.0	32.5				1.082	3.1		
8.3	31.9	...esterfield	F	85	1.124	3.8	12.2	28.5
8.3	33.2	...leigh	F	85	1.079	3.0	11.1	28.6
					1.073			
10.2	26.2	...ilip Morris		70	0.966	1.8	8.6	23.1
		...aire	FM	85	1.050	2.8	10.8	28.3
10.0	28.6	...d Gold		70	0.908	1.6	9.6	28.6
9.8	28.2				0.916			
9.4	28.1	...Maurier	F	85	1.059	2.6	10.2	28.5
9.5	24.8				1.025	2.5		
		...yers		75	1.120	2.4	10.3	23.8
10.9	24.6	...imels		70	1.005	1.9	9.0	24.8
		...imels	F	85	1.089	2.5	11.0	28.2
9.6	28.6				1.058	2.0		
		...ork		85	1.086	1.8	9.7	23.7
8.6	30.5	...ll Mall		85	1.146	2.2	11.4	24.6
10.8	27.6				1.171	2.4		
9.2	28.4	...alf & Half	F	85	1.174	2.4	13.0	28.6
		...omino		85	1.216	2.6	10.6	24.6
		...d Gold		85	1.084	2.0	10.8	24.1
8.9	24.8	...asterpiece	F	85	1.138	2.3	9.8	29.0
10.8	27.5	...ool	M	70	0.945	1.6	9.0	24.6
11.1	24.4	...atima		85	1.250	2.6	12.1	25.6
9.9	28.3	...hilip Morris		85	1.175	2.4	11.2	25.7
9.5	27.5	...randon		85	1.241	1.9	12.2	25.3
9.0	22.9	...enson & Hedges	F	100	1.264	3.0	13.9	25.9
8.5	22.5	...oliday		85	1.249	1.8	11.2	25.1
10.1	28.1	...areyton		85	1.129	2.0	11.4	22.8
					1.155	2.2		
10.9	23.1	...ll Mall	F	100	1.269	2.7	13.2	22.4
					1.258			
9.3	28.2	...aleigh		85	1.166	1.4	12.0	24.0
					1.189	1.7		
10.3	28.1							

...butt length recommend... ...was adopted. For cigare... ...per overwraps longer th... ...gth 3 mm longer than ... ...was taken as standard. ...least 3 filter pads for e... ...ttes were smoked with e... ...l brand (regular size Lu... ...on one port each smok...

...e were analyzed accordi... ...cribed by Ogg.[13] The pla... ...were weighed before ... ...were smoked and the ... ...as defined as the tar. To ...ed with a Griffith still[14] ...l spectrophotometer, w... ...e.

...retail markets showed t... ...ettes (Carlton) was on ... ...ictly different designs. ...ack did not carry the mandatory health ...arning and thus must have been fairly old. ...Because these 3 samples evidently were manu... ...ctured at appreciably different times, we ...t it desirable to test the older cigarettes in ...mparison with newer ones of the same ...rand. We were able to purchase only 40 of ...e older cigarettes and hence our selection of ...dividual cigarettes for testing had to be less ...ringent in this instance than in normal ...ircumstances.

The availability of "very old" cigarettes in ...e retail market suggested that some of the ...ow-moving brands might be relatively dry. ...Accordingly, we "equilibrated" batches of a ...opular brand (Lucky Strike) for 48 hours at ...0%, 60% and 100% relative humidity prior ...o analysis.

In still another test of the effects of hu... ...midity we tested some relatively less popular ...(low-moving) brands after both 24 and 48 hours of exposure to 60% relative humidity. Tar yield showed no consistent difference between the 2 periods of exposure for any brand and the differences which we did find were within the 95% confidence level. The data for the 2 periods of equilibration were pooled.

Variability in tar yields showed some tendency to increase as the yields increased; hence the yields per cigarette were divided into 4 ranges: under 20 mg, 20 to 24.9 mg, 25 to 29.9 mg and 30 mg and over. Separate variance estimates were calculated for each range. The variance estimate for a specified range was obtained by pooling the individual estimates of variance for the brands whose averages fell within that range.

RESULTS

Recovery of tar from the various types of cigarettes tested ranged from 8.3 to 43.4 mg

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per cigarette (Table 2). Recovery of nicotine ranged from 0.29 to 2.64 mg per cigarette. (Recovery of nicotine added to the filter pads through the use of the method described by Ogg[18] proved to be quantitative.) The tar and nicotine contents were closely correlated (Fig. 1). One brand (King Sano) deviated significantly from the others in this regard, having substantially less nicotine than would be expected on the basis of the tar yield; this brand is advertised as having a low nicotine content. Other brands with proportionately low nicotine were Cascade, Duke and Marvel. Because of the close correlation between tar and nicotine contents, we are confining our further remarks mainly to tar yield.

TABLE 2. Average Tar and Nicotine Per Cigarette

Brand	Type*	Tar (mg)	Nicotine (mg)
Marvel	KF	8.3	0.32
Cascade	KMF	9.1	0.34
Carlton	KF	9.7	0.74
King Sano	KFD	12.0	0.39
Duke	KF	12.3	0.46
Life	KF	13.6	0.97
True	KF	15.8	0.80
Kent	KF	18.8	1.10
Montclair	KMF	21.1	1.15
Spring	KMF	21.7	1.16
Galaxy	KF	22.1	1.43
Marlboro	KF	22.4	1.24
Winston	KF	22.9	1.32
Old Gold	KF	23.0	1.32
Waterford	KF	23.0	1.40
Lark	KF	23.1	1.26
Philip Morris	KF	23.2	1.46
Newport	KMF	23.3	1.34
Viceroy	KF	23.4	1.68
Salem	KMF	23.6	1.43
Paxton	KMF	23.8	1.43
Parliament	KF	24.0	1.44
L & M	RF	24.9	1.12
Benson & Hedges	RF	25.0	1.55
Tempo	KF	25.1	1.68
Tareyton	KF	25.3	1.35
Alpine	KMF	26.4	1.52
Kool	KMF	26.6	1.88
Chesterfield	R	27.0	1.18
Lucky Strike	R	27.1	1.42
Oasis	KMF	27.1	1.38
Lucky Strike	KF	27.3	1.42
Chesterfield	KF	27.6	1.72
Raleigh	KF	27.8	1.98
Philip Morris	R	28.8	1.37
Belair	KMF	29.7	2.11
Old Gold	R	29.7	1.63
du Maurier	KF	30.0	1.96
Players	R	31.0	1.67
Camels	R	31.3	1.69
Camels	KF	32.4	1.77
York	K	32.4	1.69
Pall Mall	K	33.0	1.75
Half & Half	KF	33.6	1.99
Domino	K	34.1	1.48
Old Gold	K	34.8	1.89
Masterpiece	KF	35.9	2.23
Kool	RM	36.3	2.21
Fatima	K	36.7	1.73
Philip Morris	K	37.2	2.11
Brandon	K	38.5	2.35
Benson & Hedges 100	KF	39.3	2.29
Holiday	K	41.1	2.45
Tareyton	K	41.5	1.97
Pall Mall	KF	41.6	2.20
Raleigh	K	43.4	2.64

* K—king (80–100 mm), R—regular (70 mm); F—filter, M—menthol, D—denicotinized.

There were substantial differences among cigarettes of similar types. Among cigarettes without filters tar yield depended chiefly on the length of the cigarette. The regular size cigarettes had the lower yields, 27 to 31 mg per cigarette, except for regular Kool cigarettes, which had a yield of 36 mg (Fig. 2). In general, however, the king-size cigarettes had the higher yields, 32 to 42 mg (Fig. 3). Even among cigarettes of the same length, the tar yields extended over a considerable range. Roughly 25% more tar was recovered from certain brands of king size filterless cigarettes (42 mg for Raleigh or Tareyton) than from the brand of the same type with the lowest tar yield (32 mg for York). Filter cigarettes had the greatest range of tar yields, approximately 8 to 42 mg per cigarette (Fig. 4). Among filter cigarettes most of the mentholated brands yielded tar over a rather narrow range, between 22 and 30 mg; but Cascade yielded as little as 9.1 mg (Fig. 5).

The 3 samples of Carlton cigarettes were different in tar and nicotine yields. The tar yields from "very old" and "old" cigarettes were not significantly different (6.2 and 7.5 mg/cigarette, respectively); but the "new" cigarettes yielded a third more tar (9.8 mg/cigarette), representing a highly significant difference.

Tar recovery from Lucky Strike cigarettes analyzed under standard conditions on different days was remarkably constant, averaging about 27 mg per cigarette (Fig. 6). As shown by tar recovery from Lucky Strikes stored for 48 hours under various humidities, low humidity had only a slight effect on tar yield (Fig. 7).

DISCUSSON

The biological significance of differences in the tar content of cigarette smoke has been demonstrated repeatedly. In man, a dose-response effect relating death rates to number of cigarettes consumed is well established. This dose-response effect exists not only for death in general, but also for death from specific causes, such as heart disease and cancer. Similar dose-response effects are

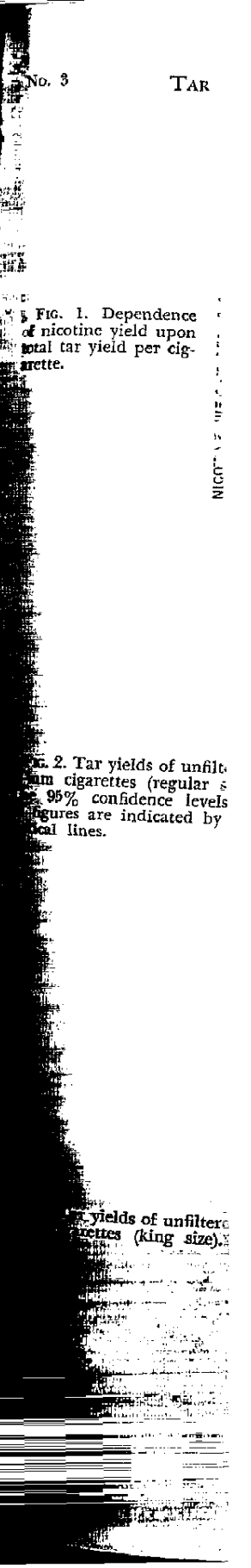

FIG. 1. Dependence of nicotine yield upon total tar yield per cigarette.

NICOTINE

g. 2. Tar yields of unfilt
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yields of unfiltere
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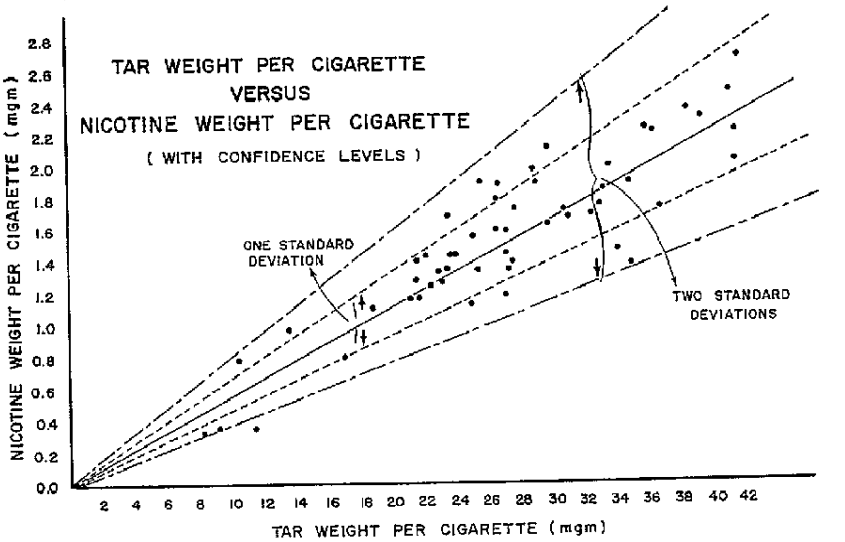

FIG. 1. Dependence of nicotine yield upon total tar yield per cigarette.

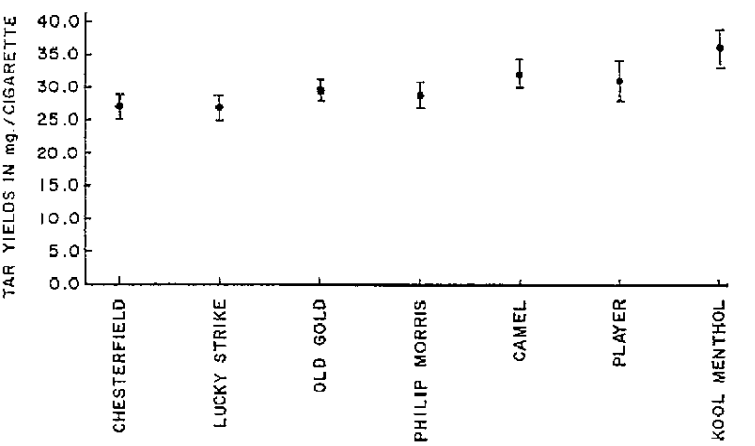

FIG. 2. Tar yields of unfiltered 70-mm cigarettes (regular size). The 95% confidence levels in all figures are indicated by the vertical lines.

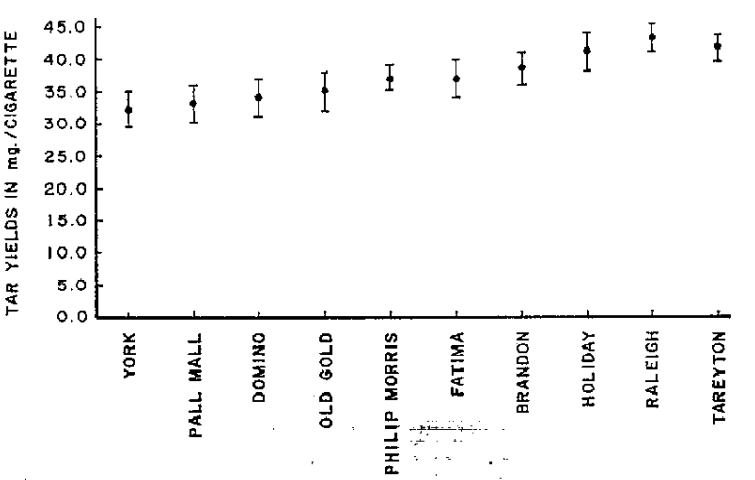

FIG. 3. Tar yields of unfiltered 85-mm cigarettes (king size).

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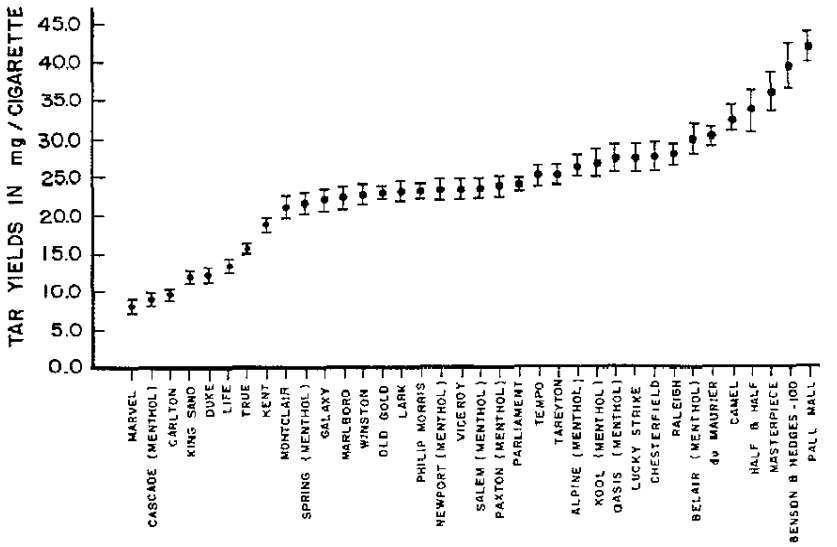

FIG. 4. Tar yields of filter-tip 80- to 100-mm cigarettes.

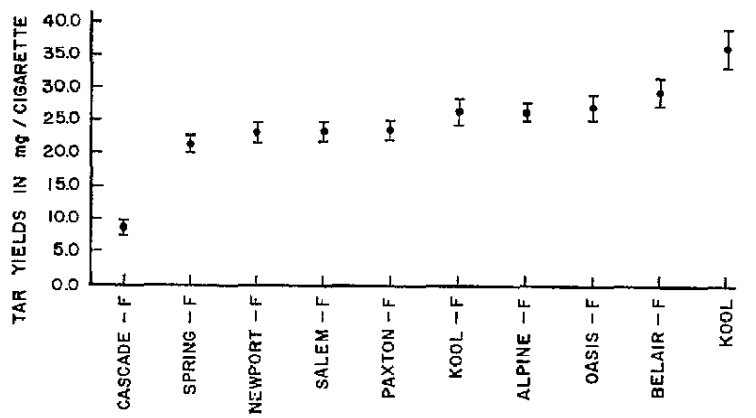

FIG. 5. Tar yields of menthol cigarettes.

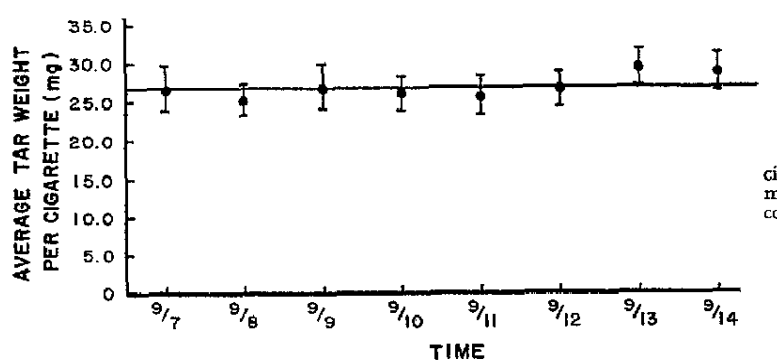

FIG. 6. Tar yields of control cigarettes (Lucky Strike) determined on 8 different days (95% confidence intervals).

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Choice of butt leng
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FIG. 4. Tar yi
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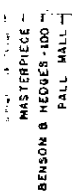

FIG. 5. Tar yields of men
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FIG. 6. Tar yields of cont
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when mice are painted with tar from
ettes. When the mice receive tar from
d brands in decreased amounts, the in-
ce of tumors is correspondingly de-
ed.[1, 20] Furthermore, when the mice re-
the entire tar contents of equal numbers
arettes of specific brands, the tumor in-
ce is proportional to the tar yields of the
ctive brands.[2, 3, 22] Accordingly, tar yield
ears to be especially important in estimat-
he potential hazard of cigarettes.

has already been pointed out in this
r, different methods of analysis for tar
nicotine in tobacco smoke give data that
often different in absolute magnitude.
t being the case, it is important to con-
the distinctive features of the methods
f.

hoice of butt length: On the basis of ob-
vations of human smoking behavior, Brad-
d et al.[4] recommended a butt length of 23
for cigarette analyses. This length, pro-
ed in 1937, subsequently was accepted in
ndard methods.[5, 19] Since the introduction
filters, however, there has been a tendency
adopt a somewhat longer butt length, so
t butts of identical length can be obtained
rdless of the presence or absence of filters.
It seems to us that such a policy might be
some value to the tobacco *chemist* but
dly of much value to the public health
entist. There is no reason to believe that
man smokers treat cigarettes with and with-
filters in the same way. On the contrary,
mmond and Wynder[10] have shown that
% of American smokers leave a butt shorter
n 25 mm, a feat manifestly impossible with
ny filters. These investigators also showed
t the average butt was clearly shorter for
arettes without filters than for those with
m. To adopt a longer butt length is to
ore the additional tar delivered to these
kers by filterless cigarettes. Under the
umstances, we have adopted the 23-mm
t for cigarettes without filters, the length
ng appropriately increased for cigarettes
h filters.

Unit for yield per unit: Similarly, we be-
ve that tar and nicotine yields are more
aningful for public health purposes when
ated in terms of yield *per cigarette* rather
an yield *per puff* or *per gram of tobacco*
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porate special features such as air vents
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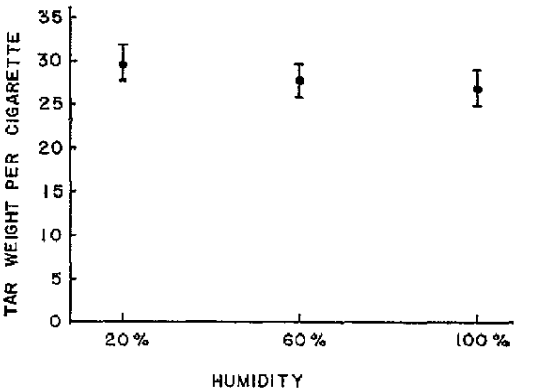

FIG. 7. Tar yields of control cigarettes (Lucky Strike) stored at various humidity levels for 48 hours.

tobacco blend, including additives or the like, the tar or nicotine yield per gram of tobacco may be of some limited interest. The average smoker, however, neither counts puffs nor weighs tobacco. That being the case, the most meaningful statistics for cigarette analyses, from a public health standpoint, are those expressed as yields *per cigarette*.

Meaning of yield per puff: When the potential effectiveness of filters is compared, the yield of tar per puff seems to have somewhat more meaning. Variation in the number of puffs is one of the principal types of variation in human smoking and hence greater stability in numerical magnitudes might be expected of yields per puff. As a matter of fact, tar recovery does tend to differ less from one sample to another when expressed as yield per puff than as yield per gram or yield per cigarette. Even so, the general distribution of the data is essentially the same regardless of which way the yield is expressed.

The manner of expressing the yield affects rankings to some extent, but groupings hardly at all. For example, 13 of the 14 king-size filter cigarettes with the highest yields per cigarette were among the 14 with the highest yields per puff and the 7 with the lowest yields per cigarette were also the 7 with the lowest yields per puff. The 14 king-size filter cigarettes with intermediate yields per cigarette are considerably reshuffled in their rankings when tar recovery is expressed as yield per puff but, since their confidence intervals overlap widely, the test system does not show distinct differences among these brands in any event and the ordering is largely fortuitous whichever way the yield is expressed.

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The point that certain filter cigarettes fall in the same range of tar recovery as do filterless cigarettes is equally strong whether tar recovery is expressed as yield per cigarette or yield per puff. The ordering of the filter brands among the filterless brands is somewhat different for yields per puff than for yields per cigarette; for instance, the brand with the highest yield per cigarette was Pall Mall, but the one with a highest yield per puff was Masterpiece. Nevertheless, the brands that have high yields per cigarette tend to have high yields per puff.

Selection of cigarettes: The procedures employed in this study or recommended for general use [5, 13] do not necessarily provide a true picture of all cigarettes bearing a specific brand name. Cigarettes with a limited range of weight and air resistance were selected in an effort to exclude atypical cigarettes that might have given results less representative of the brand. Furthermore, most of the cigarettes were obtained from a single retail outlet and cigarettes purchased in other localities might have given somewhat different results. As a rule, however, cigarettes of the same brand were fairly homogeneous.

Changes in cigarette design over a period of time are of considerable importance. The results obtained with Carlton cigarettes are highly illustrative. We believe that some of the cigarettes in the retail outlets must have been manufactured more than 8 months before they were purchased. Not only were the newer packs different in appearance but they contained cigarettes that were enough different in composition to have distinctly higher levels of tar and nicotine (Table 3). Changes in the design of a slow-selling brand may not be detectable on the retail market for a considerable period of time. This problem should be taken into account in any assay program.

TABLE 3. Tar and Nicotine Retrieval from Carlton Cigarettes from Packs of Different Designs

Type*	Yield (mg per cigarette)	
	Tar	Nicotine
Very old	6.2	.41
Old	7.3	.60
New	9.7	.74

* "Very old" cigarettes carried the label "Flavor Filter," and did not have the mandatory health warning. "Old" cigarettes carried the label "Flavor Tip" and had the health warning but did not list the tar and nicotine contents. "New" cigarettes carried the label "Filter Tip," had the health warning and listed revised tar and nicotine levels.

Validity of the test system: Regular-size Lucky Strike cigarettes were used as controls for the test system used in this study. The tar yields for these controls (Fig. 6) cover the 8-day period during which most of the tests reported in this paper were run. The confidence intervals shown in the graph enable the reader to make a direct assessment of the degree of quality control achieved in this assay. If the test system provides the best possible quality control, the confidence intervals can be expected to include the "true" yield (i.e., some horizontal line in Fig. 6 in 19 of 20 tests. In Figure 6 the horizontal line just below 27 mg is the average yield of tar during the test period represented by the graph. All but one of the confidence intervals intersect this horizontal line and the interval for September 9 is very close to the line. The confidence intervals used in the text are based on pooled variance estimates together with a separate test of Lucky Strikes, and the interval for the separate test (25.3 to 29. includes all of the yields shown in Figure Under the circumstances, the confidence intervals used in Figures 2 through 5 seem provide an adequate indication of the producibility of the results.

Influence of moisture content: The data ported here are for the total, or wet, ticulate matter retained on the Cambrid filter. Inasmuch as the moisture content of may have no health significance, it wou perhaps, be of interest to compare the deliv of tar on a dry weight basis. The repor content of moisture in different brands cigarettes ranges from about 7 to 14%, most of the samples falling in the range 8 to 10%. [17] Thus the differences in moist content between brands is not sufficie great to significantly change the relative r ings in either Table 2 or the various figure

Variations within types of cigarettes: C parison of yields from cigarettes with without filters shows that the amounts o and nicotine to which the smoker is exp can be varied by the industry. Variab from one brand to another is substantial any type of cigarette but it is greates filter cigarettes (Fig. 4). Furthermore, presence of menthol had no consistant tionship to the yield of either tar or nic

At least 2 differences in cigarette desig reflected in tar yields. Extra-long (100 Pall Mall filters and Benson & Hedge filter cigarettes gave higher tar yield cigarette than did any of the other

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...Many brands of filter ...es to substantial amou ...r filters. In this study, c ...s had no discernible ...tine recovery. Such ... rising, however, sinc ...lly intended for sel ...ous constituents of t ...bridge filter is not desi ...iable quantities of gases ...*roblems in switching!* ...nt study are substantia ...tandpoint of public h ...bers of the populatio ...nd older indicates tha ...tte smokers want to ... well known that ma ...sible to break the hab ... such smokers are in ...nds with low tar and ...es in this direction ... health gains sinc ...tes smoked each day ...haracteristics of the ... present study indic ...range of choice, eve ...ame type, to permi

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ettes. The increase in tar yield illustrates detrimental effect of allowing a greater ber of puffs per cigarette and thus a ter opportunity for exposure to tar during the smoking of a specified number of rettes. This factor is particularly evident comparing the average number of puffs cigarette when the cigarettes are listed order of increasing tar yield (Table 1). econd difference reflected in tar yields is r design. As the weight of the filter increased, the tar yield per puff decreased ($r = 38$; $P<0.05$). For example, Marvel had a r weighing 20 mg and gave 0.9 mg per whereas the high-tar Pall Mall had a r weighing only 15 mg and gave 3.1 mg puff. Filter effectiveness also can be correlated with the air resistance of the entire arette (Table 1).

Many brands of filter cigarettes include aces to substantial amounts of charcoal in eir filters. In this study, charcoal in cigarette lters had no discernible effect on tar or icotine recovery. Such a result is hardly rprising, however, since the charcoal is ually intended for selective removal of seous constituents of the smoke and the ambridge filter is not designed to collect appreciable quantities of gases.

Problems in switching! The data of the esent study are substantially important from he standpoint of public health. A survey of embers of the population of Buffalo aged 8 and older indicates that about 60% of all igarette smokers want to give up smoking.[11] It is well known that many smokers find it mpossible to break the habit.[15] A large number of such smokers are interested in shifting to brands with low tar and nicotine contents. Changes in this direction offer appreciable public health gains since the number of cigarettes smoked each day is one of the most table characteristics of the cigarette habit.[7]

The present study indicates that there is mple range of choice, even among cigarettes of the same type, to permit most smokers to shift to brands with lower yields of tar and nicotine. Unfortunately, there is evidence that cigarettes of very high tar and nicotine outputs also are being produced. A trend toward extra-long cigarettes seems to be developing, and the public health implications of this trend are highly disturbing. A smoker who switches from one of the medium-tar filter cigarettes to Pall Mall filters or Benson & Hedges 100 immediately doubles his exposure to tar and nicotine, if, as is likely, he continues to smoke the same number of cigarettes and to smoke them to approximately the same butt length. The smoker may be unaware of his greatly increased health hazard since he may suppose that he is being protected by the filter.

Timeliness of analyses: Cigarette manufacture is a variable process, even under the best of controls. The tobacco leaf provided in commerce is a product of its environment, both natural and artificial (i.e., fertilizer, suckering agents, insecticides, irrigation, etc.). Furthermore, manufacturing processes have undergone repeated changes over the years.

It now seems clear that manufacturers are able to produce cigarettes with almost any yield of tar and nicotine from very low to very high. The wide variety of filters available is an obvious tool for this purpose. Unfortunately, not all filters are effective. The width of cut in the leaf is also important in determining tar and nicotine yield.[20] Reconstituted tobacco sheet offers still more opportunity for engineering cigarettes. This material is becoming more common in cigarettes and in 1964 it accounted for about 15% of the total cigarette tobacco produced in the United States.[12] Such factors show that analyses for tar and nicotine must be carried out frequently if they are to offer an accurate description of cigarettes currently available. They also show that the industry does have the capability for manufacturing less dangerous cigarettes.

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Errata

In the January 1967 issue of CANCER two sets of headings were deleted erroneously. On page 10, in the article on "Behavior of Cancers of the Human Lung in Short-term Tissue Cultures" by Russell P. Sherwin, MD, Valda Richters, BS, and Arnis Richters, MS, is a list of eight distinctively different types of cancer cell behavior. So that this list may serve as a type of shorthand for those working with tissue culture cancers, it is reprinted here with the original labels referred to in the text:

I. **Organ culture, tumor tissue and related stroma**
   a. Intact structure and architecture;
   b. Altered structure and intact architecture;

II. **Semiorgan culture, tumor tissue with loss of stromal relationship (i.e., loss of structure)**
   a. Intact architecture;
   b. Altered architecture (tumor "flattening");

III. **Monolayer formation (loss of original architecture)**
   a. Organoid monolayer ("organization");
   b. True monolayer (sheet, group or individual cell);

IV. **Multilayer formation**
   a. Passive (conversion of tumor in explant to "piled-up" monolayer);
   b. Active (vertical proliferation of monolayer).

On pages 91 and 92 of the article on "Carcinoma of the Uterine Cervix: A Study of 864 Patients" by Iver C. Nielson, Robert R. Smith, John R. McLaren and J. Elliott Scarborough headings were deleted from Tables 7 and 8. These are reproduced correctly below:

Stage	Total eligible for 60 (120) mo follow-up A	No. of pts. living at 60 (120) mo: Free of ca. B	No. of pts. living at 60 (120) mo: With ca. C	No. of pts. died 0–60 (120) mo: With ca. D	No. of pts. died 0–60 (120) mo: Free of ca. E	No. lost to follow-up F	% minimal survival at 60 (120) mo*	% determin survival 60 (120) m

In addition, instructions for calculations in the footnotes of these tables should have appeared as follows: $\frac{* (B + C)}{A}$ and $\frac{\dagger (B + C)}{A - (E + F)}$.

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